

# Accuracy of sonographic fetal gender determination: predictions made by sonographers during routine obstetric ultrasound scans

## Abstract

**Objectives:** The purpose of this study was to determine the accuracy of sonographer predictions of fetal gender during routine ultrasounds. Primarily, the study sought to investigate the accuracy of predictions made in the first trimester, as requests from parents wanting to know the gender of their fetus at this early scan are becoming increasingly common. Second and third trimester fetuses were included in the study to confirm the accuracy of later predictions. In addition, the mother's decision to know the gender was recorded to determine the prevalence of women wanting prenatal predictions.

**Methods:** A prospective, cross sectional study was conducted in a specialist private obstetric practice in the Illawarra, NSW. A total of 640 fetuses across three trimesters were examined collectively by seven sonographers. Fetal gender was predicted using the sagittal plane only in the first trimester and either the sagittal or transverse plane in later trimesters. Phenotypic gender confirmation was obtained from hospital records or direct telephone contact with women postnatally.

**Results:** Results confirmed 100% accuracy in predictions made after 14 weeks gestation. The overall success rate in the first trimester group (11–14 weeks) was 75%. When excluding those scans where a prediction could not be made, success rates increased to 91%. Results were less accurate for fetuses younger than 12 weeks, with an overall success rate of 54%. Male fetuses under 13 weeks were more likely to have gender incorrectly or unable to be assigned. After 13 weeks, success rates for correctly predicting males exceeded that of female fetuses. Statistical differences were noted in the success rates of individual sonographers. Sixty seven percent of women were in favour of knowing fetal gender from ultrasound. Publicly insured women were more likely to request gender disclosure than privately insured women.

**Conclusions:** Sonographic gender determination provides high success rates in the first trimester. Results vary depending on sonographer experience, fetal age and fetal gender. Practice guidelines regarding gender disclosure should be developed. Predictions prior to 12 weeks should be discouraged.

**Keywords:** fetal gender, first trimester, gender determination, obstetric ultrasound, routine ultrasound, sonographer

## Introduction

It is nearly 40 years since ultrasound was first used to evaluate the obstetric patient,<sup>1</sup> today ultrasound scanning is firmly entrenched in antenatal care. The value of ultrasound screening in detecting and monitoring fetal malformation, placental position and multiple pregnancies is undeniable.<sup>2</sup> Initially fetal gender assignment by ultrasound was indicated in fetuses at risk of sex and X-linked disorders in order to reduce the need for invasive testing.<sup>2</sup> However, it is now typically performed in response to parental wishes.

Most commonly gender predictions are made in the second or third trimester, however

with improvements in ultrasound technology<sup>4</sup> identification of fetal gender in the first trimester is becoming a reality.

The 1989 study conducted by Emerson *et al.*<sup>3</sup> was the first to identify the 'sagittal sign'<sup>3</sup> as a means of determining gender at first trimester ultrasounds. This study found that a focal bulge creating a cranial acute angle indicated male genitalia, while a bulge creating a caudal acute angle indicated female genitalia<sup>3</sup> (Figure 1).

A similar description was utilised by Whitlow, *et al.*<sup>4</sup> When viewing a fetus in the sagittal plane, a cranial or vertically directed fetal phallus was noted to be a feature of the male fetus. Female genitalia demonstrate a caudally directed phallus

## Manette Kearin<sup>1</sup>

Dip App Sc (Nursing),  
BNursing, Grad Dip Ed  
(primary), DMU, MSc  
(midwifery)

## Karen Pollard<sup>2</sup>

ADipDMR,  
GCertUnivTeach&Learn,  
MHed, MEd

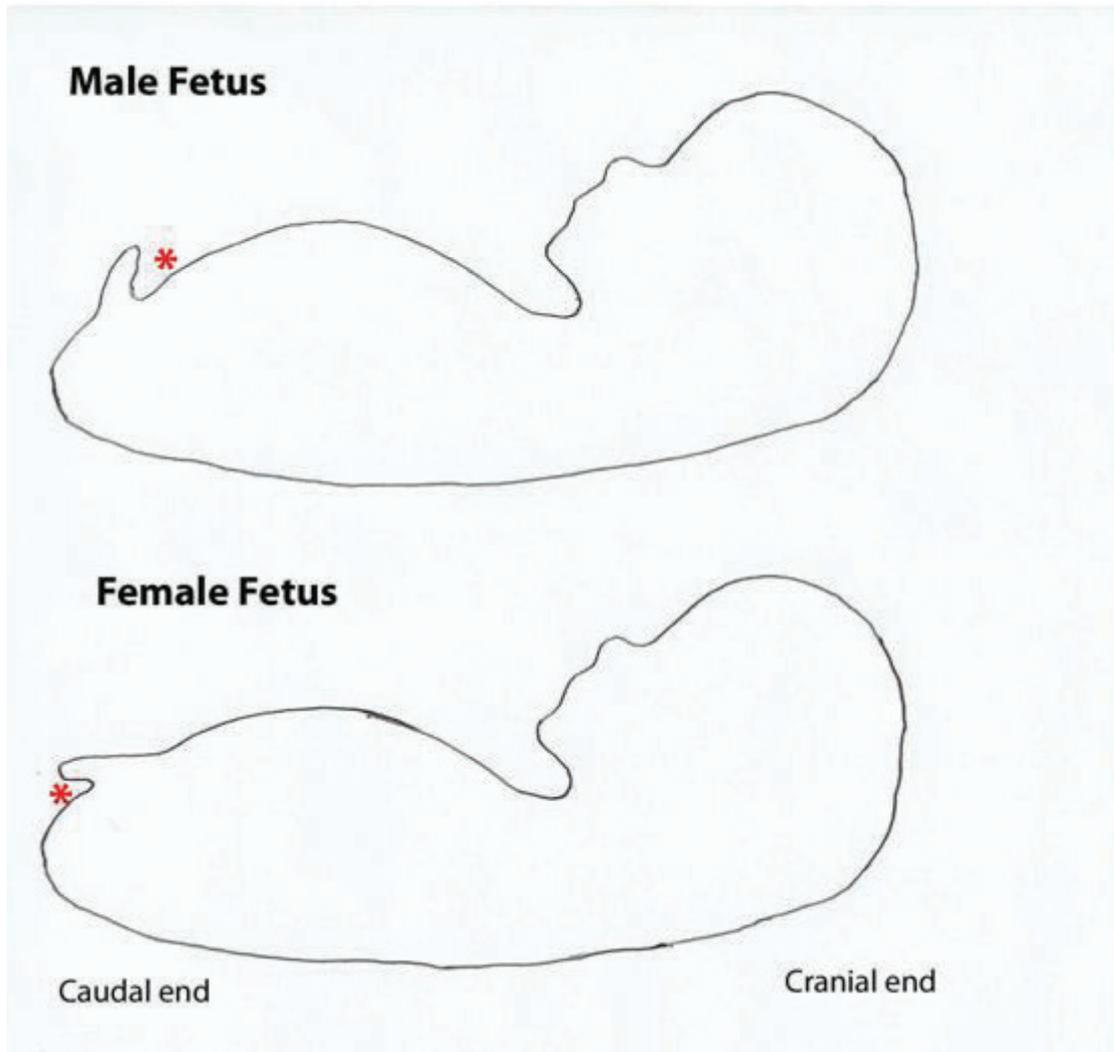
## Ian Garbett<sup>2</sup>

BSc, GDipMathematics,  
MSc

<sup>1</sup>South Coast Ultrasound for  
Women  
Wollongong  
New South Wales  
Australia

<sup>2</sup>Charles Sturt University  
Wollongong  
New South Wales  
Australia

Correspondence to email  
kearin@aapt.net.au



**Figure 1:** Diagrammatic representation of the 'sagittal sign' described by Emerson.

which is considered to represent the clitoris.<sup>4</sup>

Some studies<sup>5,6</sup> have explored the possibility of quantifying the angle of the tubercle or phallus. The angle of the genital tubercle to a horizontal line through the lumbosacral surface was measured with a protractor. An angle of  $> 30^\circ$  was assigned a male fetus. A female was assigned when the genital tubercle was parallel or convergent to the horizontal line ( $< 10^\circ$ ). In the study conducted by Youssef, *et al.*<sup>6</sup> the best cut-off for male gender determination was found to be between  $27^\circ$  and  $29^\circ$ . These studies involved an independent researcher performing measurements away from the clinical setting. It was an intention of this study to make subjective predictions during routine scans without the patient being aware that gender was being assessed (when required). For these reasons quantifying the angle was not considered.

The numbers of parents desiring to know their fetus's gender was also of interest. A study conducted by Shipp, *et al.*<sup>7</sup> found that 58% of parents had learned or planned to learn the gender of their baby. Their study was conducted in 2001 at a large referral centre in Boston (USA). In a study conducted at the Nepean Hospital (NSW, Australia) in 2008, it was found that 64% of mothers wanted to know the sex of their baby.<sup>8</sup> The study conducted at Nepean Hospital, found common factors related

to maternal desire to seek fetal gender. These included low education level, low income level, increased parity and having no partner.<sup>8</sup> The common demographic factors found in the study by Shipp, *et al.*<sup>7</sup> included partners not employed in fulltime work, low household income, unwed mothers, maternal age ( $< 22$  and  $> 40$  years) and the lack of a college degree. While the scope of this study did not extend to investigating the factors impacting the decision to pursue fetal gender determination, it did seek to quantify the numbers of patients making gender requests. The study allowed definition of those patients with private health cover to those birthing through the public system.

At the practice where the present study was conducted, requests for fetal gender predictions during first trimester, routine nuchal translucency (NT) screening were being frequently heard. For sonographers it was becoming increasingly difficult to navigate the issue of gender disclosure. Sonographers at this practice were keen to explore their own abilities and limitations. There was also a need to develop formal practice policy guidelines regarding disclosure of fetal gender.

As a result, this study sought to investigate the feasibility and accuracy of gender predictions made by sonographers during routine scans. The results would then be used to guide sonographers and develop practice guidelines.



**Figure 2:** Male fetus at 12 weeks 5 days.



**Figure 3:** Female fetus at 12 weeks 3 days.

### Methods and materials

This prospective study was conducted at a private specialist obstetrics/gynaecology practice in the Illawarra (NSW, Australia). The practice is the main referral centre in the Illawarra and South Coast region. Women were referred by general practitioners, hospital doctors, midwives and private obstetricians. Of the women who attended the practice for their obstetric ultrasound scans, approximately one third had private health insurance. Two thirds of the women used the publicly funded, universal health care system operated by Medicare Australia and were likely to birth at the local public hospital.

In the Illawarra, women generally had three routine scans during their pregnancy. These include the first trimester scan (NT scan), a 19-week morphology scan, and a third trimester fetal wellbeing scan (34 weeks).

All scans were attended on General Electric E8 ultrasound machines by one of seven sonographers. Sonographer experience ranged from a third year trainee sonographer to a sonographer with more than 30 years experience. During the study period, two locum sonographers were employed to cover permanent staff on leave. While both were very experienced, neither performed any scan in the first trimester group.

Standard policy and procedure guidelines were strictly followed throughout the study period (specific practice and ASUM guidelines<sup>9</sup>). The length of scan time was not increased for the purpose of obtaining study data.

Ethics approval was obtained from Charles Sturt University (approval number 414/2012/15).

Pregnant women who attended the practice for a routine scan within the study period (January 2013) were recruited. Patients booked for nuchal translucency scans (first trimester), morphology scans (second trimester) and fetal growth and wellbeing scans (third trimester) were included. Patients under the age of 16 and those unable to read or understand English were excluded from the study.

On arrival for their ultrasound, women were informed of the study and were provided with written information. Informed consent was then obtained from those women willing to participate. Participation was voluntary. Women were reassured that the gender prediction would not be conveyed to them unless they specifically requested it. The signed consent form and a data collection sheet were attached to the referral form. Prior to commencing the scan,

sonographers ensured the consent form was complete and provided an opportunity for further information or clarification. The ultrasound was then conducted in the usual manner.

At the conclusion of each scan, when the woman had left the room, sonographers completed the data collection form. The form contained simple options enabling the sonographer to complete it quickly and easily by placing a cross in the appropriate boxes. The form indicated the attending sonographer, pertinent patient details, age of fetus, gender prediction, reason for a failure to predict gender (if applicable) and the woman's desire to know gender. Once complete, the data collection form was sealed in an envelope and securely stored with the expected delivery date and place of delivery recorded on the front.

After the delivery date had passed, the phenotypic gender was sought and recorded on the data sheet. The birth gender was obtained through hospital records or by direct phone contact with women.

Fetuses in the second and third trimesters were scanned in either transverse or sagittal planes at the discretion of the attending sonographer. Prior to the study, sonographers were instructed to view the genital area of first trimester fetuses in a sagittal view only. A caudally directed tubercle was to be recorded a female, a cranial directed tubercle was recorded as a male, using the same technique described by Emerson, *et al.*<sup>3</sup> The following ultrasound images depict examples of both a male and female fetus (Figure 2 and 3).

During the study period, scans were performed on a total of 640 fetuses. Third trimester gender predictions were made on 217 fetuses, including one twin pregnancy. Two hundred and fifteen fetuses were included in the second trimester group including five twin pregnancies. The first trimester group included 208 fetuses of which there were three twin pregnancies. Gestational age was calculated from either LMP, a previous dating scan or taken from referral details.

All data was entered and tabulated using the Microsoft Excel program. The three trimester groups were entered separately to allow for individual analysis. Statistical analysis using Chi squared test and the Z statistic were used, with  $P < 0.05$  considered statistically significant.

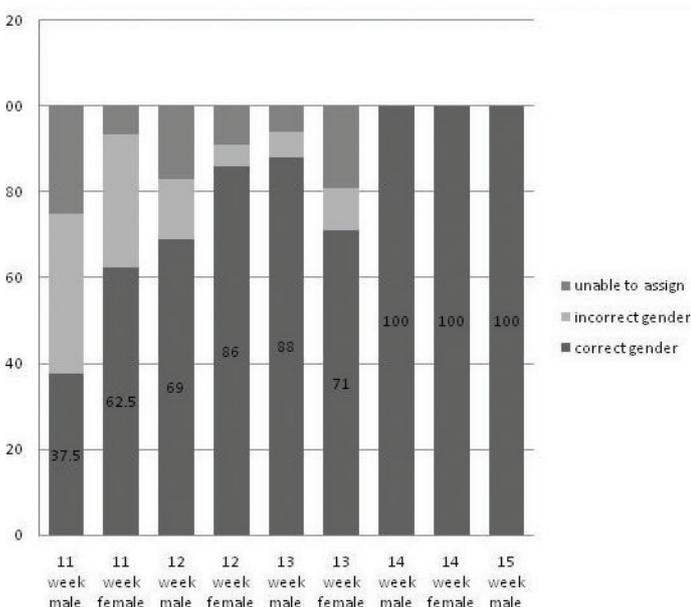
### Results

Of the 640 fetuses, 323 (50.5%) were born male and 317 (49.5%)

**Table 1:** First trimester results.

Gestational age	11–11+6 weeks		12–12+6 weeks		13–13+6 weeks		14–14+6 weeks		15–15+6 weeks	
Gender not assigned	3/24	12.5%	19/143	13%	5/38	13%	0		0	
Correct male	3/8	37.5%	54/78	69%	16/19	84%	1/1	100%	1	100%
Incorrect male	3/8	37.5%	11/78	14%	1/19	5%	0		0	
Correct female	10/16	62.5%	55/64	86%	15/21	71%	1/1	100%	0	
Incorrect female	5/16	31%	3/64	5%	2/21	10%	0		0	
Total correct when attempted	13/21	62%	110/124	89%	30/33	91%	2/2	100%	1	100%
Total incorrect when attempted	8/21	38%	14/124	11%	3/33	9%	0		0	
Overall correct	13/24	54%	110/143	77%	30/38	79%	2/2	100%	1/1	100%
Total cases studied	24		143		38		2		1	

**Table 2:** Gender specific differences in the first trimester.



were born female. Only one fetus was excluded from the study due to ambiguous genitalia and other anomalies (Trisomy 21 was confirmed on invasive testing). Phenotypic gender was confirmed for all study participants.

Gender assignment was possible in 215 of the 217 (99%) fetuses in the third trimester group. Increased maternal body mass index (BMI) and unfavourable fetal lie contributed to the two fetuses without gender assignment. Correct gender assignment was achieved in all remaining fetuses.

Gender assignment was possible in 214 of 215 (99.5%) fetuses in the second trimester scan. In one case the gender could not be determined due to increased maternal BMI, uterine fibroids and unfavourable fetal lie. Correct gender was achieved in all remaining fetuses.

Results were significantly different for the first trimester group. Gender assignment was attempted in 87% (181 of 208) of fetuses. In the majority of cases the reasons for inability to predict gender included unfavourable lie and increased maternal BMI.

The overall success rate of predicting fetal gender in the

first trimester was 75% (156/208). When excluding those fetuses where a prediction was not made, correct determination increased to 91% (156/181). The full results of the first trimester group are shown in Table 1.

The above table demonstrates how accuracy rates improved with advancing gestational age. For fetuses in the 11–11week six-day group, success rates were poor. Only 54% (13/24) were correctly predicted. Fetuses between 12–12 weeks 6 days, demonstrated a high degree of accuracy in predictions. Overall, 77% (110/143) of fetuses in this group were predicted correctly. For fetuses between 13–13 weeks 6 days, success rates rose to 79% (30/38). Although only a small number of fetuses were examined between 14 weeks and 16 weeks, all were correctly predicted.

The feasibility rate of making predictions was relatively stable through each of the groups. For those fetuses in the 11-week group the ‘unable to be assigned’ rate was 12.5%. While 13 % of fetuses in the 12-week and 13 week groups were unable to be assigned.

Gender-specific differences in accuracy rates were noted. Predictive errors were more common in young male fetuses. Male fetuses under 12 weeks gestation were correctly predicted 37.5% of the time compared to 62.5% of female fetuses in the same group. For male fetuses under 13 weeks, 69% were correctly predicted compared to 86% of females. Once fetuses reached 13 weeks, more male fetuses were correctly predicted compared to female fetuses (84% to 71%). Using a Chi-squared Test, results according to gender were found to be statistically significant (87.2% confidence).

Gender-specific differences in feasibility rates were also noted. In the 11 and 12 week groups combined, 17% of males were ‘unable to be assigned’ compared to 9% of females. By 13 weeks more females were represented in the ‘unable to be assigned’ category. Gender specific differences are highlighted in Table 2.

There was a statistical difference in the accuracy rates among sonographers (P value = 0.00055). When comparing the five sonographers who scanned fetuses in the first trimester, the overall success rates were 77%, 49%, 86.5%, 71% and 100%. The rate of inability to predict was 7%, 41%, 5%, 11% and 0%. The rate of incorrect predictions was 16%, 10%, 8%, and 18%

and 0% (Table 3). It is important to note that the sonographer who obtained a 100% accuracy rate had only attended six first trimester ultrasound scans within the study period. The remaining four sonographers attended 28 ultrasound scans or more.

Of the total study sample, 67% of women wanted to know or had already sought fetal gender determination. Of the privately insured women, only 50% opted to know their fetus' gender compared to 75% of women within the public health system.

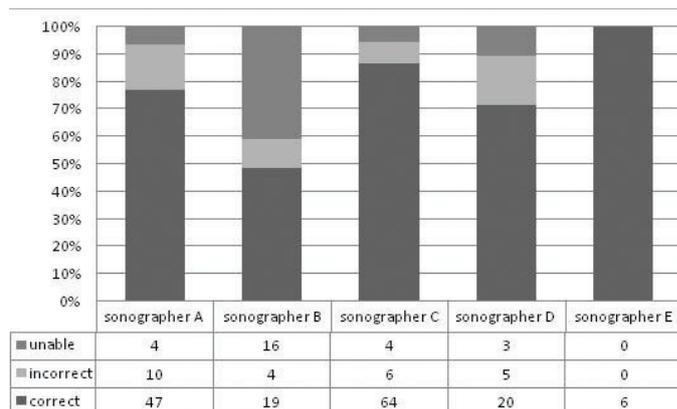
## Discussion

The results of this study indicate ultrasound gender predictions by sonographers are 100% sensitive for accurately predicting the gender in the second and third trimesters. The overall success rate of correctly identifying fetal gender in the first trimester was much lower (75%). This result was also lower than several other studies.<sup>5,6,10,11</sup> There are several possible explanations for this finding. Firstly, this study included predictions made by sonographers with varying levels of experience. In particular, the trainee sonographer (sonographer B) recorded significantly more fetuses in the 'unassigned' group, thus affecting overall success rates. Secondly, the practice where this study was attended has a policy allowing support people and their children to attend ultrasounds. Consequently, sonographers often deal with multiple distractions. In studies where predictions were made by researchers away from the clinical setting,<sup>5,6,10,11</sup> these factors would be negated. The study conducted by Whitlow, *et al.*<sup>4</sup> was attended under similar conditions to this study. Predictions were made by visual assessment of the direction of the fetal phallus only by multiple sonographers in real-time scanning situations.<sup>4</sup> Their success rates were 75% for 12 weeks and 79% at 13 weeks<sup>4</sup> which are comparable to the results in this study.

It must also be noted that the study did not allow for an increase in scan time and many parents did not wish to know the gender of their fetus. Some prediction errors may have been made as a result of time constraints or by sonographers attempting to minimise parents viewing the fetal genital area.

This study demonstrated a strong correlation between fetal age and accuracy rates of gender predictions. Interestingly success rates for predictions on fetuses under 12 weeks were very poor (54%). When using the z-test statistic it was found that the predictive ability of sonography (using this sample) was not significantly better than guessing. For fetuses between 12 weeks and 12 weeks and 6 days overall success rates reached 77%. This climbed to 79% and then 100% in the following weeks. Comparable results were noted in other studies.<sup>4,10</sup> The study by Whitlow, *et al.*<sup>4</sup> found that the overall success rates of correctly assigning fetal gender increased with gestational age from 46% to 75%, 79% and 90% at 11, 12, 13 and 14 weeks respectively. The study by Hsiao, *et al.*<sup>10</sup> showed the same trend. Success rates rose from 71.9% at 11 weeks to 92% and 98.3% in subsequent weeks.<sup>10</sup>

Feasibility rates in this study were not found to be affected by gestational age. Approximately 12–13% of fetuses were classified as 'unable to be assigned' in the 11 week, 12 week and 13 week groups. These results were not reflected in other studies.<sup>2,4</sup> Whitlow, *et al.*<sup>4</sup> found that at 11 weeks, 41% of fetuses were unable to be assigned. This decreased to 13%, 8% and 2% at 12, 13 and 14 weeks respectively.<sup>4</sup> The study conducted by Hsiao, *et*



**Table 3:** Individual sonographer results.

*al.*<sup>10</sup> found fetal gender was unable to be assigned in 40.6% of fetuses in the 11 week group.<sup>10</sup> This fell to 5.4% in the 12-week group and 2.3% in the 13 week group.<sup>10</sup>

Results of this study indicate that more errors occur with young male fetuses than young female fetuses. The accuracy of predicting males compared to females has shown conflicting results in previous studies. Several studies<sup>12–15</sup> found significant differences between success rates of predicting male fetuses. Younger males were predicted incorrectly more commonly. In contrast, the study conducted by Chelli, *et al.*<sup>11</sup> found accuracy rates were not different between sexes (87.9% to 83.3%).

Differences in success rates between genders are not unexpected when considering normal embryology. From 12 weeks gestation pronounced gender specific changes occur in the structure of the urogenital sinus.<sup>15</sup> In males the urogenital sinus is replaced by the scrotal and urethral raphe. This process, combined with elongation of the genital tubercle, displaces the phallus to a raised position.<sup>15</sup> Therefore male fetuses show an increase in the angle of the genital tubercle from the horizontal with increasing crown-rump length.<sup>15</sup> Until this process has occurred gender predictions are unreliable.

The experience and skill of the sonographer requires consideration. This study highlighted the differences between success rates of an inexperienced sonographer and those with at least five years experience. Results showed while the trainee sonographer had comparable numbers of incorrect predictions, she was much more likely to refrain from making a prediction. The similar study by Whitlow, *et al.*<sup>4</sup> found no statistical difference in the accuracy rates among six different operators.

It is also important to note that sonographers in this study were completing high volumes of early fetal scans, and as a result, may be more confident in making predictions than those seeing few obstetric patients. Further study opportunities exist to examine the impact of experience levels and sonographer accuracy rates. In particular, a study comparing sonographers working in general practices to those working in a specialist practice would be of interest.

In this study the proportion of parents who request fetal gender determination varied between the women in the public health system and women with private health insurance. While individual demographic factors were not recorded, it may be possible that fewer privately insured women choose prenatal gender determination due to reasons associated with their

typically higher maternal age, education and economic status. This assumption is supported by Shipp, *et al.*<sup>7</sup> and Bauman, *et al.*<sup>8</sup> whose studies identified common demographic factors that lead to an increased desire to know fetal gender.

### Conclusion

Requests from parents for fetal gender determination at ultrasounds are common. These requests are now being heard during first trimester scans. While sonographers who perform high volumes of obstetric ultrasounds are very accurate in providing gender predictions in the second and third trimesters of pregnancy, lower accuracy rates are obtained in the first trimester. Sonographers need to make women aware that errors occur with early predictions, particularly those made prior to 12 weeks, and that predictions cannot always be made. Sonographers should have an awareness of their skill and limitations in order to adequately counsel women. Specific practice policies regarding gender disclosure would provide guidance and protection to staff.

### References

- 1 Callen PW. *Ultrasonography in Obstetrics and Gynecology*. 5th ed. Philadelphia: Saunders Elsevier; 2008.
- 2 Eze CU, Ezugwu FO, Agbo JA. Sonographic determination of fetal gender in the second and third trimesters in a private hospital in Enugu, Southeast Nigeria. *Radiography* 2010; 16: 292–96.
- 3 Emerson DS, Felker RE, Brown DL. The sagittal sign: An early second trimester sonographic indicator of fetal gender. *J Ultrasound Med* 1989; 8: 293–97.
- 4 Whitlow BJ, Lazanakis MS, Economides DL. The sonographic identification of fetal gender from 11 to 14 weeks of gestation. *Ultrasound in Obstetrics and Gynaecology* 1999; 13: 301–4.
- 5 Efrat Z, Perri T, Ramati E, Tugendreich D, Meizner I. Fetal gender assignment by first trimester ultrasound. *Ultrasound Obstet Gynaecol* 2006; 27: 619–21.
- 6 Youssef A, Arcangeli T, Radico D, Contro E, Guasina F, Bellissi F, Maroni E, Morselli-Labate AM, Farina A, Pilu G, Pelusi G, Ghi T. Accuracy of fetal gender determination in the first trimester using three-dimensional ultrasound. *Ultrasound Obstet Gynecol* 2011; 37: 557–61.
- 7 Shipp TD, Shipp DZ, Bromley B, Sheahan R, Cohen A, Lieberman E, Benacerraf B. What factors are associated with parents' desire to know the sex of their unborn child? *Birth* 2004; 31 (4): 272–79.
- 8 Bauman ES, Hollander LN, Fauchon DEV, Eggink AJ, Lotgering FK, Benzie RJ. What factors are associated with parental desire to find out the sex of their baby? *ASUM Ultrasound Bulletin* 2008; 11 (1): 19–24.
- 9 ASUM Policy & Standards: A1 Statement on the Safety of Ultrasound in Grey Scale Imaging In Obstetrics. Available at [http://www.asum.com.au/newsite/files/documents/policies/PS/A1\\_policy.pdf](http://www.asum.com.au/newsite/files/documents/policies/PS/A1_policy.pdf).
- 10 Hsiao CH, Wang HC, Hsieh CF, Hsu JJ. Fetal gender screening by ultrasound at 11 to 13+6 weeks. *Acta Obstetrica et Gynecologica* 2008; 87: 8–13.
- 11 Chelli D, Methni A, Dimassi K, Boudaya F, Sfar E, Zouaoui B, Chelli H, Chennoufi MB. Fetal sex assignment by first trimester ultrasound: a Tunisian experience. *Prenatal Diagnosis* 2009; 29: 1145–48.
- 12 Mazza V, Di Monte I, Pati M, Contu G, Ottolenghi C, Forabosco A, Volpe A. Sonographic biometrical range of external genitalia differentiation in the first trimester of pregnancy: Analysis of 2593 cases. *Prenat Diag* 2004; 24: 677–84.
- 13 Podobnik MP, Podgajski M, Podobnik P, Brlecic I. First-trimester determination of fetal gender by ultrasound. *Ultrasound in Obstetrics and Gynecology* 2003; 22: (suppl. 1); 84.
- 14 Mazza V, Falcinelli C, Paganelli S, Contu G, Mantuano SM, Battafarano SD, Forabosco A, Volpe A. Sonographic early gender assignment: a longitudinal study in pregnancies after invitro fertilisation. *Ultrasound Obstet Gynaecol* 2001; 17: 513–16.
- 15 Efrat Z, Akinfenwa OO, Nicolaidis KH. First-trimester determination of fetal gender by ultrasound. *Ultrasound Obstet Gynaecol* 1999; 13: 305–7.